

CLAIMS

1. A multi-function vibrating actuator device, in which there are provided an outer-magnet type of magnetic circuit including a discal yoke with a pole piece at a center thereof, a yoke plate and a ring magnet as a single unit, forming a gap that functions as a magnetic gap between an outer face of the pole piece and respective inner faces of the magnet and yoke plate, a diaphragm fastened to an top of a voice coil, a suspension including a plurality of spring arms that extend along an outer periphery thereof from a support portion for supporting the magnetic circuit, a substantially cylindrical housing that is open on both ends thereof, and a cover,

the magnetic circuit being supported within the housing by the suspension, tips of the spring arms of which are attached to the sides of the housing, the voice coil being located within the magnet gap, the opening at one end of the housing being covered by the diaphragm with an outer edge of the diaphragm being attached to a rim of the opening of the housing and the opening at the other end of the housing being covered by the cover with an outer edge of the cover being attached to a rim of the opening of the housing, and the magnetic circuit being made vibrate within the housing by an electrical signal being applied to the voice coil,

wherein an air passage hole is formed at least at one part among said housing, cover and diaphragm, said magnetic circuit is assembled with an outer surface thereof in close proximity to an inner surface of the housing so as to create a clearance between an outer surface of the magnetic circuit and an inner surface of the housing that measures more than 0% and not more than 2.5% of the inside radius of the housing, and the amount of movement of interior air in a space formed by said diaphragm and said magnetic circuit and of interior air in a space formed by said magnetic circuit and said cover is restricted by said clearance so as to expand a range of frequencies at which said magnetic circuit is able to vibrate.

2. The multi-function vibrating actuator device of claim 1, wherein said yoke plate includes a ring with brim projections at an outer periphery of the ring in accordance with the

number of spring arms, the brim projections being arranged so as not to overlap points of attachment between said housing and suspension.

3. The multi-function vibrating actuator device of claim 1 or 2, wherein a through hole is formed in said magnetic circuit.

4. A multi-function vibrating actuator device, in which there are provided an outer-magnet type of magnetic circuit including a discal yoke with a pole piece at a center thereof, a yoke plate and a ring magnet as a single unit, forming a gap that functions as a magnetic gap between an outer face of the pole piece and respective inner faces of the magnet and yoke plate, a diaphragm fastened to an top of a voice coil, a suspension including a plurality of spring arms that extend along an outer periphery thereof from a support portion for supporting the magnetic circuit, a substantially cylindrical housing that is open on both ends thereof, and a cover,

the magnetic circuit being supported within the housing by the suspension, tips of the spring arms of which are attached to the sides of the housing, the voice coil being located within the magnet gap, the opening at one end of the housing being covered by the diaphragm with an outer edge of the diaphragm being attached to a rim of the opening of the housing and the opening at the other end of the housing being covered by the cover with an outer edge of the cover being attached to a rim of the opening of the housing, and the magnetic circuit being made vibrate within the housing by an electrical signal being applied to the voice coil,

wherein an air passage hole is formed at least at one part among said housing, cover and diaphragm, a ring is fitted around an outer periphery of said magnetic circuit so as to create a clearance between an outer surface of the ring and an inner surface of the housing that measures more than 0% and not more than 2.5% of the inside radius of the housing, and the amount of movement of interior air in a space formed by said diaphragm and said magnetic circuit and of interior air in a space formed by said magnetic circuit and said cover is restricted by said clearance so as to expand a range of frequencies at which said magnetic circuit is able to vibrate.

5. A multi-function vibrating actuator device, in which there are provided an inner-magnet type of magnetic circuit in which a pole piece and a yoke are fixed to a magnet as a single unit, forming a gap that functions as a magnetic gap, a diaphragm fastened to an top of a voice coil, a suspension including a plurality of spring arms that extend along an outer periphery thereof from a support portion for supporting the magnetic circuit, a substantially cylindrical housing that is open on both ends thereof, and a cover,

the magnetic circuit being supported within the housing by the suspension, tips of the spring arms of which are attached to the sides of the housing, the voice coil being located within the magnet gap, the opening at one end of the housing being covered by the diaphragm with an outer edge of the diaphragm being attached to a rim of the opening of the housing and the opening at the other end of the housing being covered by the cover with an outer edge of the cover being attached to a rim of the opening of the housing, and the magnetic circuit being made vibrate within the housing by an electrical signal being applied to the voice coil,

wherein an air passage hole is formed at least at one part among said housing, cover and diaphragm, said magnetic circuit is assembled with an outer surface thereof in close proximity to an inner surface of the housing so as to create a clearance between an outer surface of the magnetic circuit and an inner surface of the housing that measures more than 0% and not more than 2.5% of the inside radius of the housing, and the amount of movement of interior air in a space formed by said diaphragm and said magnetic circuit and of interior air in a space formed by said magnetic circuit and said cover is restricted by said clearance so as to expand a range of frequencies at which said magnetic circuit is able to vibrate.

6. A multi-function vibrating actuator device, comprising:

a magnetic circuit forming a magnetic path;

a suspension supporting said magnetic circuit;

a diaphragm being placed facing said magnetic circuit;

a voice coil being inserted into a magnetic gap formed in said magnetic circuit; and

a housing enclosing said magnetic circuit,

wherein said magnetic circuit is placed so as to create a clearance between an outer surface of the magnetic circuit and an inner surface of said housing, and said clearance restricts the amount of air movement that measures more than 0 mm and not more than 0.2 mm.

7. A multi-function vibrating actuator device, comprising:

a movable part including a magnetic circuit that forms a magnetic path and a brim that extends in a radial direction of the magnetic circuit;

a suspension supporting said movable part;

a diaphragm being placed facing said movable part;

a voice coil being inserted into a magnetic gap formed in said magnetic circuit; and

a housing enclosing said movable part,

wherein said movable part is placed so as to create a clearance between an outer surface of the movable part and an inner surface of said housing, and said clearance restricts the amount of air movement that measures more than 0 mm and not more than 0.2 mm.

8. A vibrating actuator device, comprising:

a magnetic circuit forming a magnetic path;

a suspension supporting said magnetic circuit;

a voice coil being inserted into a magnetic gap formed in said magnetic circuit; and

a housing enclosing said magnetic circuit,

wherein said magnetic circuit is placed so as to create a clearance between an outer surface of the magnetic circuit and an inner surface of said housing, and said clearance restricts the amount of air movement that measures more than 0 mm and not more than 0.2 mm.

9. A vibrating actuator device, comprising:

a movable part including a magnetic circuit that forms a magnetic path and a brim that extends in a radial direction of the magnetic circuit;

a suspension supporting said movable part;

a voice coil being inserted into a magnetic gap formed in said magnetic circuit; and
a housing enclosing said movable part,

wherein said movable part is placed so as to create a clearance between an outer surface of the movable part and an inner surface of said housing, and said clearance restricts the amount of air movement that measures more than 0 mm and not more than 0.2 mm.